



# Integrated Energy Systems: Technologies, Program Structure, and Applications



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**Oak Ridge National Laboratory**

**Integrated Energy Systems (IES)  
Peer Review Meeting**

**Nashville, Tennessee  
April 30, 2002**



**OAK RIDGE NATIONAL LABORATORY**  
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY



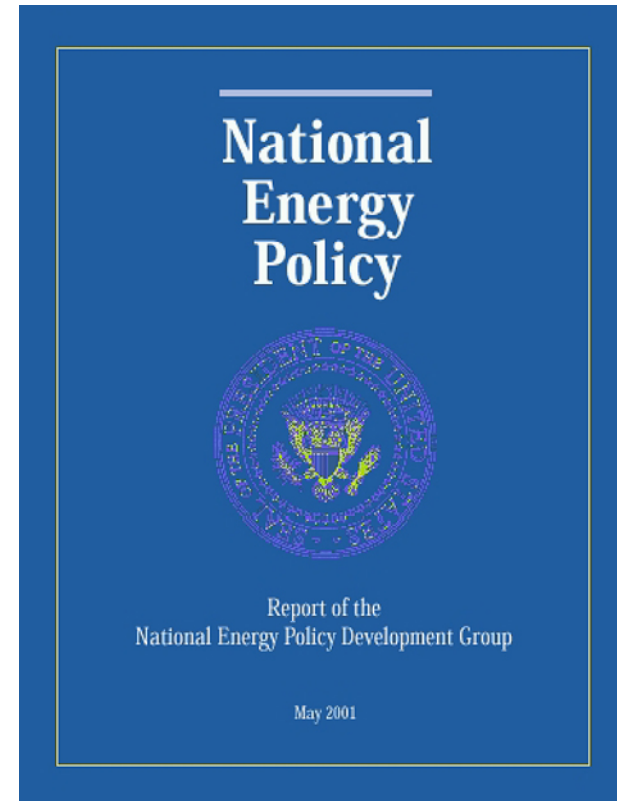


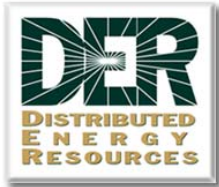
# National Energy Policy



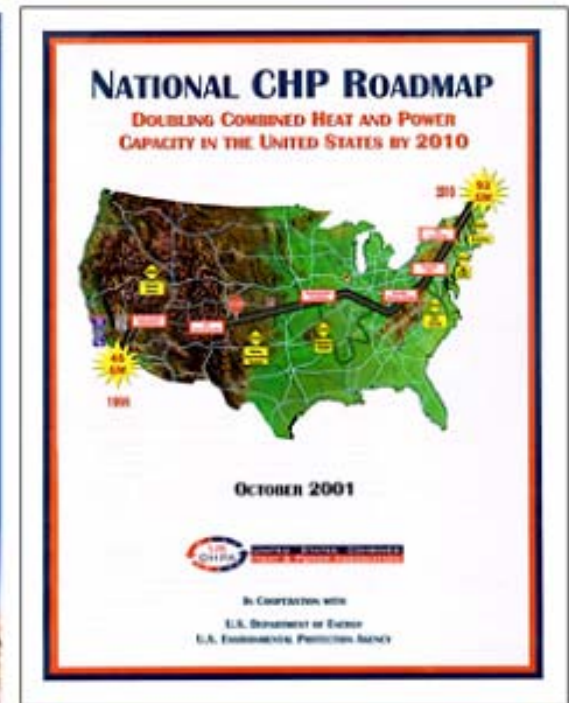
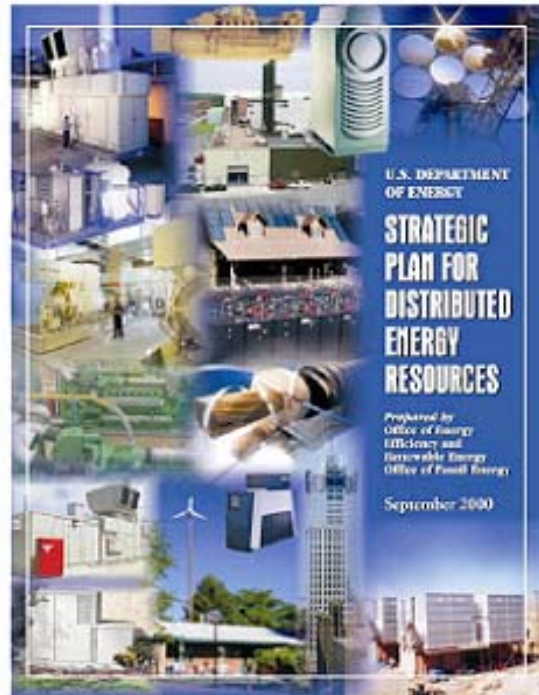
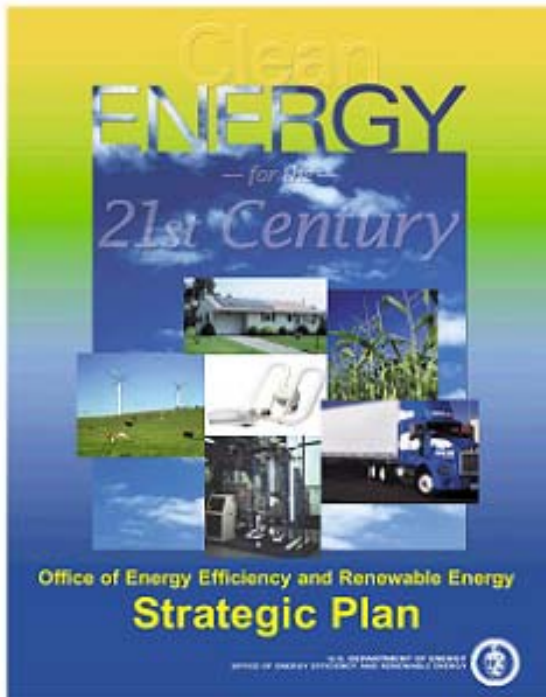
***Of the 105 total recommendations...***

- 21 affect distributed energy
- 13 affect T&D
- 8 affect international activities
- 17 affect renewable energy





# Integrated Energy Systems / Thermally Activated Technologies: Integral Part of DOE-DER-CHP Strategic Plans





# Contributing to EERE/DER Goals



- IES/TAT Program contributes to two of EERE's three major goals:

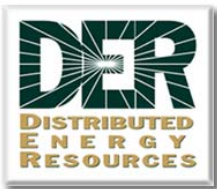
## **Goal**

Increase the supply and use of clean energy resources and increase the reliability of the energy systems.

### ***Measurable Objectives & Benefits***

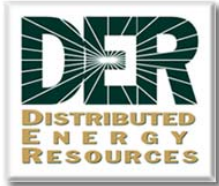
- *By 2010, increase the amount of the nation's distributed power to 20% of new electricity capacity to mitigate transmission and distribution constraints by increasing U.S. on-site power generation capacity.*
- *By 2010, double the capacity of combined heat and power systems in the U.S. from the 1999 level to make use of thermal energy normally wasted in the generation of power.*





# The CHP Goal and Roadmap

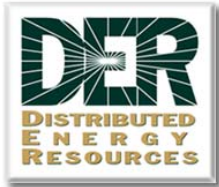




# CHP and BCHP Roadmapping Events



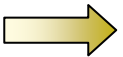
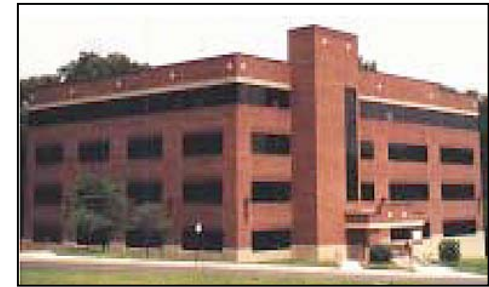
<u>Date</u>	<u>Event</u>	<u>Location</u>
December 1, 1998	CHP Summit	Alexandria, VA
March 1, 1999	CHP Data Workshop	Washington, DC
March 11-12, 1999	CHP Initiative Founders Meeting	Chicago, IL
June 1-3, 1999	CCHP Roadmap Workshop	Chantilly, VA
June 8-9, 1999	CHP Vision Workshop	Washington, DC
June 28, 1999	CHP Analysis Workshop	Washington, DC
October 6, 1999	Combined Heat and Power – A New York Perspective	Albany, NY
November 8-9, 1999	BCHP Technology Program Planning Workshop	Chicago, IL
November 10-11, 1999	Lake Michigan Regional CHP Roadmap Workshop	Chicago, IL
January 12-13, 2000	BCHP Process Workshop	Washington, DC
January 19-20, 2000	Northeast Regional CHP Roadmap Workshop	Piscataway, NJ
February 1-2, 2000	International Symposium on Combined Heat and Power	Washington, DC
March 20-21, 2000	Pacific Northwest Regional CHP Challenge Workshop and Exposition	Seattle, WA
March 20-21, 2000	BCHP Policy Workshop	College Park, MD
April 6, 2000	Upper Northeast CHP Workshop	Orono, ME
May 16, 2000	New Mexico Summit on Combined Heat and Power	Albuquerque, NM
August 14-15, 2000	Texas CHP Workshop	Houston, TX
October 12-13, 2000	National CHP Roadmap Workshop	Baltimore, MD
October, 2001		Baltimore, MD



# Program Portfolio



Fuel



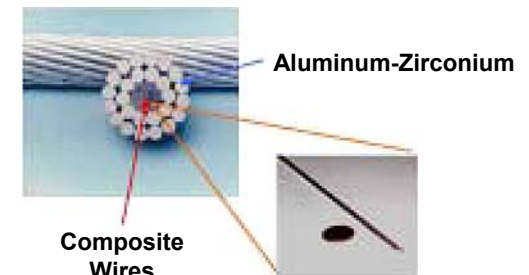
*Technology Development:*  
Microturbines, reciprocating engines, fuel cells, materials, storage

*Technology Packages:*  
Integrated CHP systems, chillers desiccants

*End-use Integration: Demand Management, controls, sensors*



## Composite Conductor



*Electric and Gas Integration:*  
Load management, sensitive loads, power electronics

*Distribution Systems:* Load management, power parks, microgrids, storage, ups, controls, DC grids

*Transmission System: Wire materials, tools*



# IES Mission



***The IES Mission is to perform the research, development and verification of a new class of distributed electric and thermal energy delivery systems for use at or near end-user sites.***

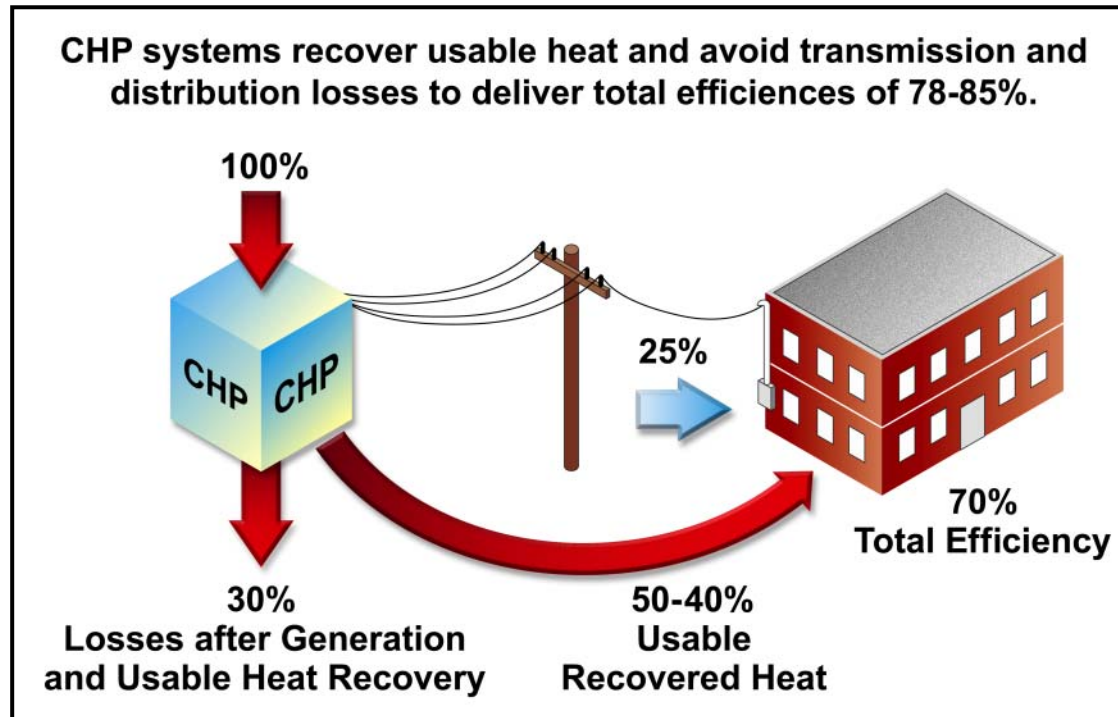




# Distributed Energy-IES Benefits



- Increases systems efficiency
- Provides energy choice
- Reduces CO<sub>2</sub> emissions
- Conserves fuel resources
- Improves reliability
- Increases energy security
- Improves energy delivery utilization



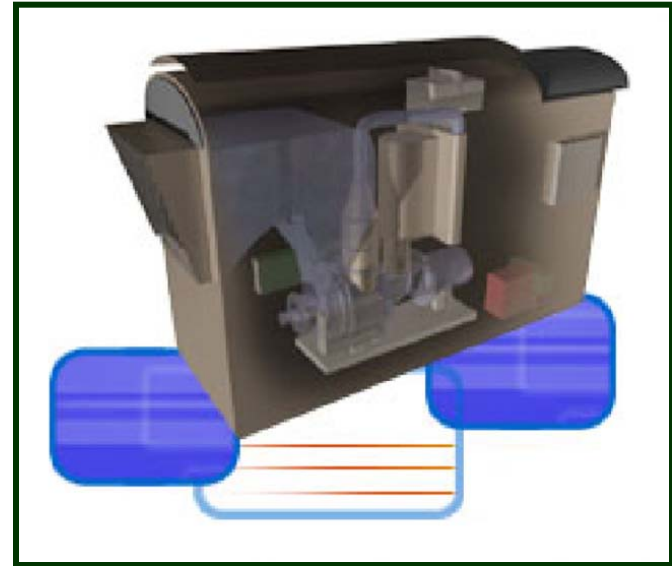
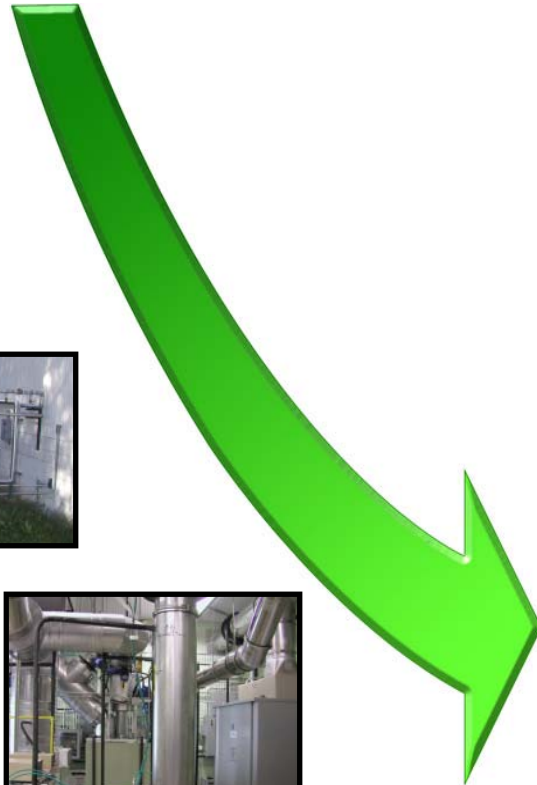


# IES Vision

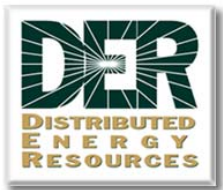
## Packaged System Integration



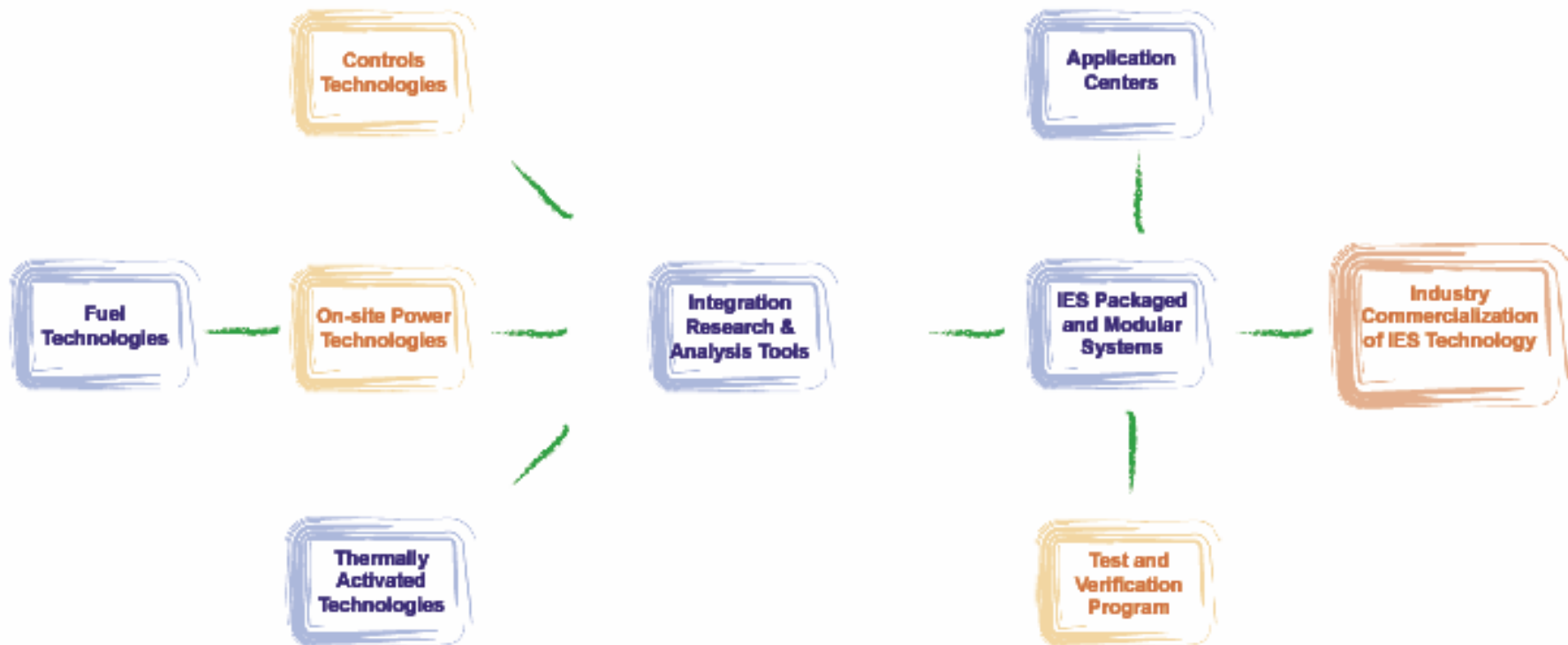
**2001: Individually optimized products combined on site**

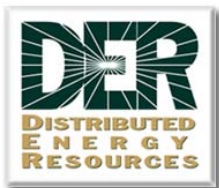


**2010: IES – single optimized package from manufacturer**

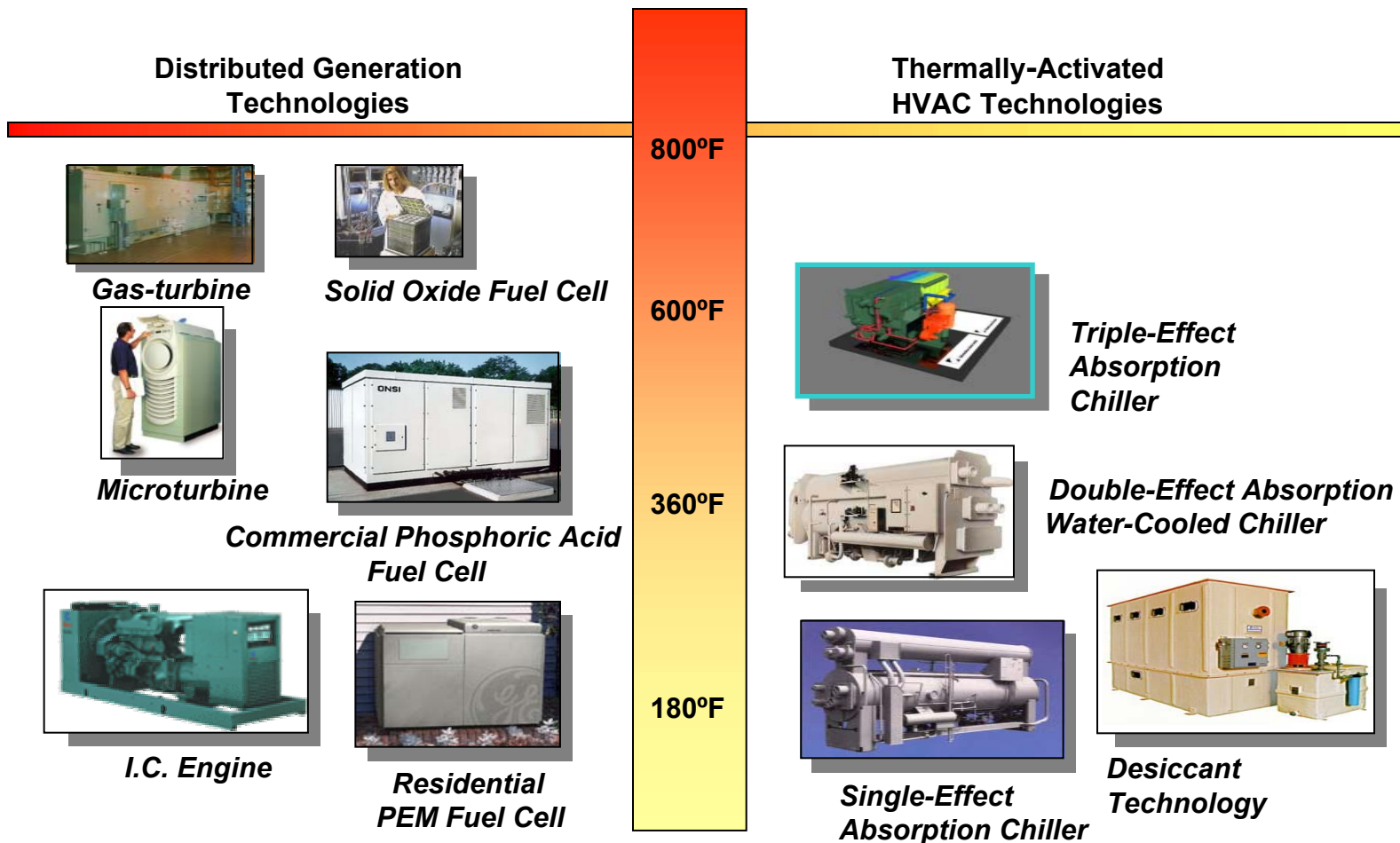


# IES and TAT Program Elements





# Thermally-Activated Technologies Are Key to Improving Overall Efficiency of DE

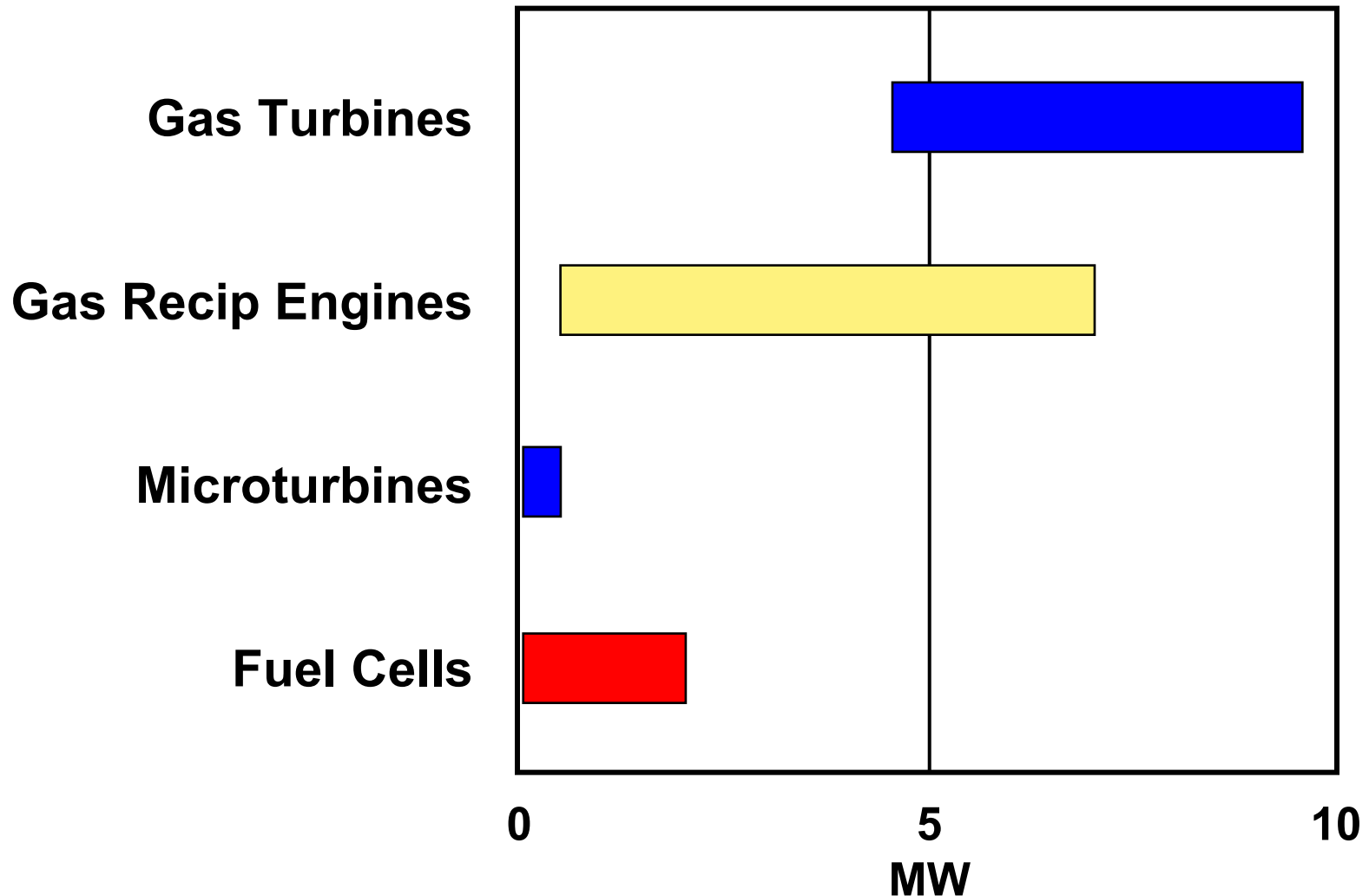


**Recoverable Energy Quality (Temperature) and HVAC Technology Match**





# Primary DG Solutions



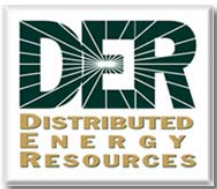


# CHP Integration Laboratory at ORNL (part of DER Lab Network)

Integration  
Research &  
Analysis Tools

Evaluate electric/thermal parameters, design tools and analysis, IES DG/TAT equipment integration R&D to optimize CHP performance



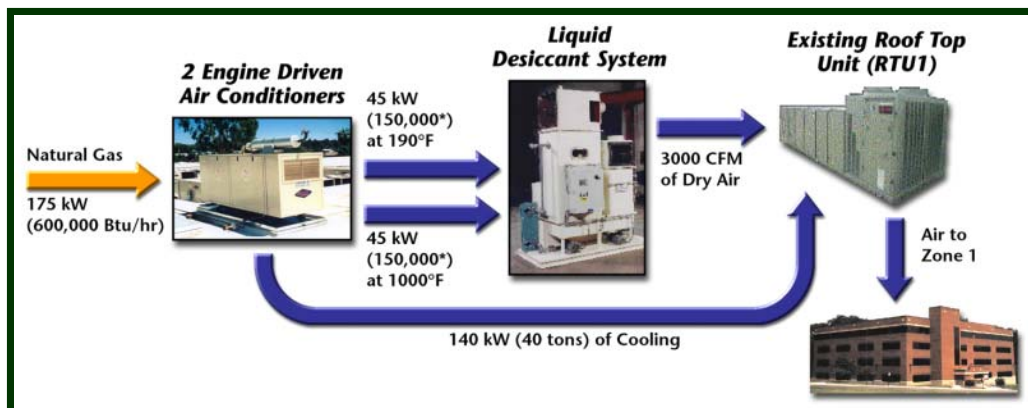
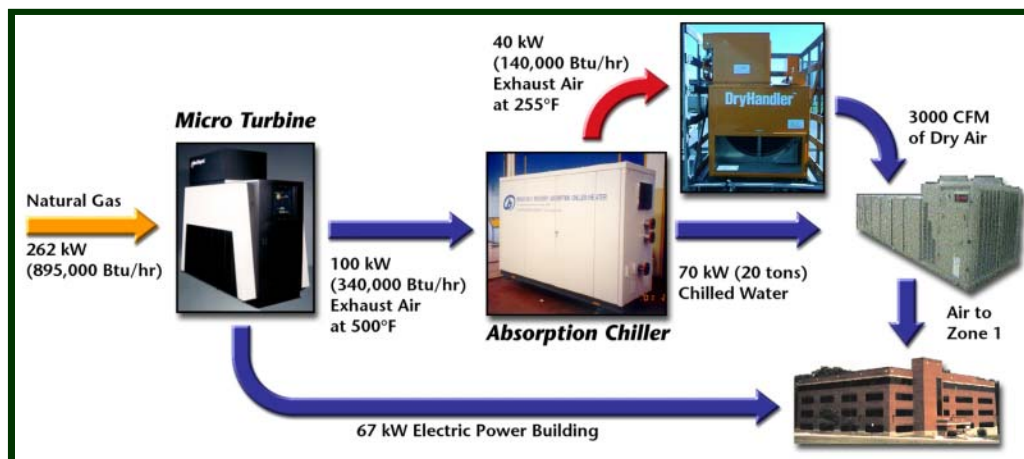


# University Test Center for IES/Building Integration CHP

Integration  
Research &  
Analysis Tools



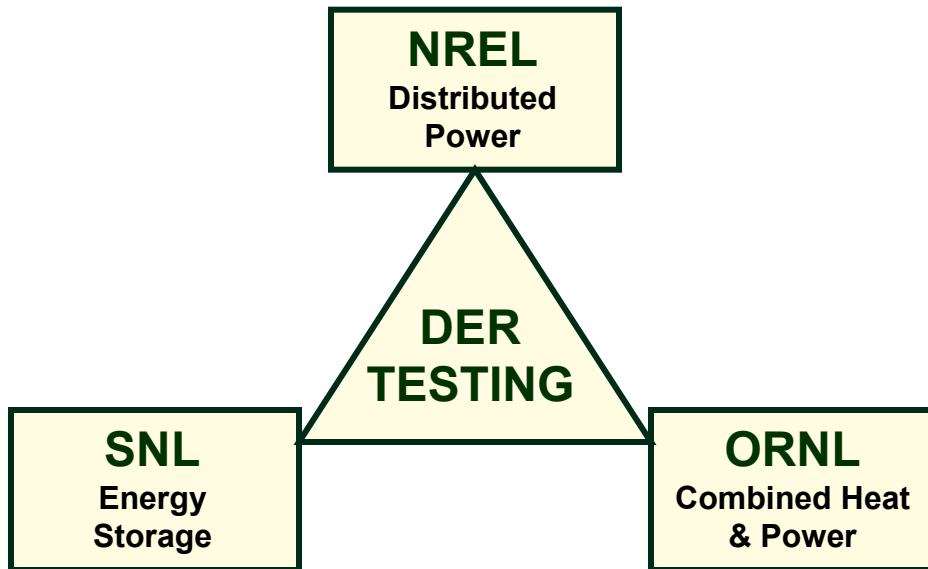
University of Maryland,  
College Park



- Integrate IES into building, HVAC System
- Test advanced controls, diagnostics, operating strategies



# National Laboratory Coordination for Distributed Energy Resource (DER) Testing is Currently Underway



## NREL/ORNL

- DG and CHP testing procedures, evaluations and building performance

## ORNL/SNL

- Power electronics development and testing

## SNL/NREL

- System integration and manufacturer development testing

**A Work in Progress**





# Seven Industry Teams Selected for Awards

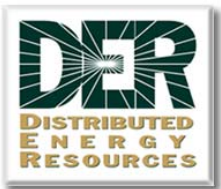


## Large-Scale Modular IES:

- Honeywell Laboratories
- Burns and McDonnell
- Gas Technology Institute

## Small-Scale Packaged IES:

- United Technologies Research Center
- Ingersoll Rand
- NiSource Energy Technologies
- Capstone Turbine Corporation



# Building on a Strong Foundation

IES Packaged  
and Modular  
Systems

- 5 MW gas turbine system with heat recovery, chiller
- 1,000 RT double-effect absorption chiller
- Inlet air cooler uses 300 RT of Chilled water output
- Operating since 1996
- O&M costs reduced from
  - \$\_\_\_\_\_/yr “pre-IES”
  - \$\_\_\_\_\_/yr with IES



*OPRYLAND Hotel and Convention Center*

*Case Study provided by: IC Thomason Associates, Inc., Consulting Engineers, Nashville, TN*

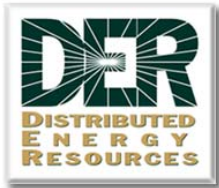


# **Benefits of Packaged CHP Systems**

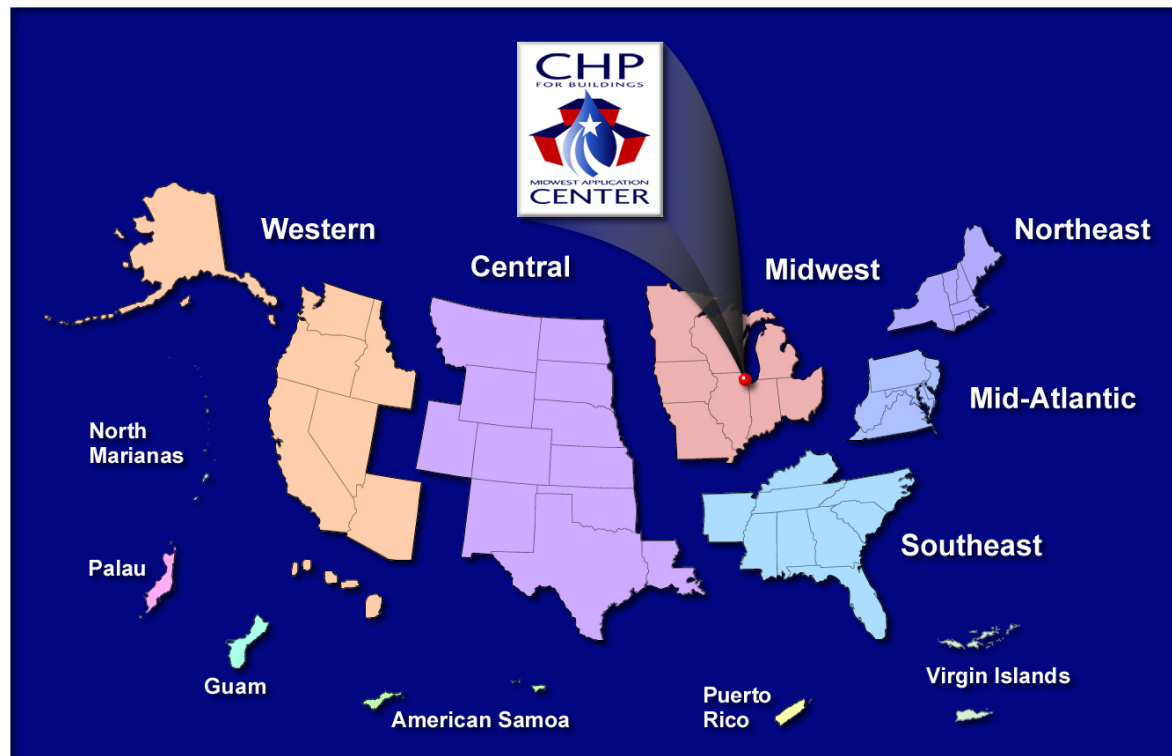


- **Compared to today's custom engineered CHP systems, packaged systems should:**
  - Improve performance (efficiency)
  - Increase reliability
  - Reduce first (capital plus installation) cost
  - Reduce maintenance cost
- **Packaged Systems will simplify the evaluation, specification, bidding and purchasing of CHP systems.**
- **This will enable many more architects, engineers, developers, and building owners to easily consider and use these systems.**

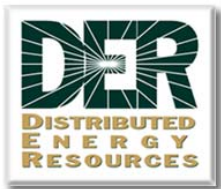
# University of Illinois-Chicago: Midwest Regional CHP Applications Center



- Facilitate CHP projects, technical assistance
- Region-specific information, application knowledge





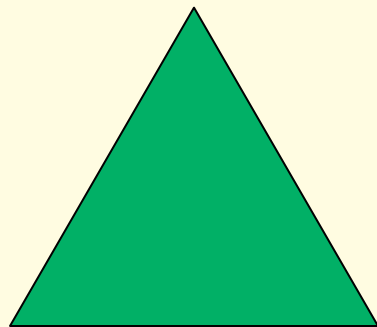


# The Strategy



## An Integrated Approach

Technologies



Policies

Markets

RD&D



Public-Private  
Partnerships



Energy and  
Environmental  
Policies



## The Ultimate Goal

*A competitive marketplace for expanding the use of clean, efficient, reliable, and affordable distributed energy resources*



# IES-TAT Program Goals



## Year 2010:


- To develop the technology, application knowledge, and infrastructure necessary to enable IES to provide - at least 8 GW of on-site electrical power and an additional 10 GW of *useful* thermal energy.
- This effectively contributes a total of 18 GW of affordable efficient energy to the Nation's energy network.



# CHPB Web Site

## <http://www.chpb.net>





### Cooling, Heating, and Power for Buildings

Reduce energy cost • Improve power reliability • Increase energy efficiency • Improve environmental quality

**News & Events**

**General Public**

**Technical Professionals**

**Building Owners**

**Policy Makers/Planners**

**Financial Institutions**

**Solicitations**

**Library**

**Relevant Links**


**DOE Staff**

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*Click for State-specific info*



### A New Perspective on Energy

Integrated systems for cooling heating and power (CHP) for buildings, incorporate multiple technologies for providing energy services to a single building or to a campus of buildings. Electricity to such buildings is provided by on-site or near-site power generators using one or more of the many options: internal combustion (IC) engines, combustion turbines, microturbines or microturbines, and fuel cells. In CHP systems, waste heat from power generation equipment is recovered for operating equipment for cooling, heating, or controlling humidity in buildings, by using absorption chillers, desiccant dehumidifiers, or heat recovery equipment for producing steam or hot water. These integrated systems are known by a variety of acronyms: CHP, CHPB (Cooling, Heating and Power for Buildings), CCHP (Combined Cooling Heating and Power), BCHP (Buildings Cooling, Heating and Power), and IES (Integrated Energy Systems).

CHP systems provide many benefits, including:

- reduced energy costs,
- improved power reliability,
- increased energy efficiency, and
- improved environmental quality.

These systems maximize efficiency of energy resources by utilizing thermal energy, generally wasted, from power generation equipment.


The objective of this site is to provide you with information on CHP systems to facilitate your decisions relating to these systems. Information on the site has been organized to address anticipated needs of various user groups. Click on a link of your choice to learn about some of the basics, benefits, success stories, and much more about CHP for buildings.

As you move through the site, your current location will be identified by "bread crumbs" within the gray bar along the top of all pages. Available sub-topics will appear in the list of links, on the left of the page, below the link for the major category currently open. The footer for each page also contains links to all the major sections of this site and the major organizations providing support for it.

### News & Events

**ASHRAE Holds Symposium on CHPB**

January 13-16, 2002  
Atlantic City, NJ



The American Society of Heating, Refrigerating and Air-Conditioning Engineers held a symposium on CHP for Buildings.

Papers presented covered:  
*CHP Technology Potential,  
CHP Demonstration Projects  
at Federal Facilities,  
Evaluation of CHP Systems,  
Status of Fuel Cell Systems*

[more details](#)

- [Events](#)
- [News Archive](#)